with rubber, will resist the action of standard acids, and shows no sign of oxydation and dissolution. The rubber coating is done very quickly with a concentrated chloroformic solution. The dipping in and drying is repeated several times. I have furnished now all the burettes used by my students with this simpler contrivance ($1.00) and have found my expectations more than realized. The surface of contact between the rubber and the standard solutions is so small, that a deteriorating influence on the latter could not be noticed.

I must acknowledge my obligation to Mr. J. Zentmayer, the well-known optician and mechanician, of this city, for the practical execution of my ideas and for many valuable suggestions in the course of my experiments. Any further information that may be deemed necessary shall most gladly be given.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

No. III.

ON AMERICAN TELLURIUM AND BISMUTH MINERALS.

By F. A. Genth.

(*Read before the American Philosophical Society, August 21st*, 1874.)

On several occasions I have given descriptions and analyses of tellurium minerals, which have been found associated with the gold ores of this country. Since my last paper on this subject (Amer. Journ. of Science [2] XLV., 306–319) several highly interesting discoveries have been made, which not only augment the list of species, but also corroborate some of my former observations.

Most important is the occurrence of the tellurium ores at the Red Cloud Mine, near Goldhill, in Boulder County, Colorado. Prof. B. Silliman (Journ. of Science [3] VIII. 25–33), has given a very accurate and careful description of some of the minerals found at this locality, and an exceedingly interesting account of the geological position of the vein.

Through the liberality of my friend J. F. L. Schirmer, Esq., Superintendent of the United States Mint at Denver, Colorado, I have been put in possession of a considerable quantity of very pure and excellent material for investigation, including several varieties not mentioned by Prof. Silliman.

Another interesting locality of tellurium minerals is the Briggs or King's Mountain Gold Mine, sometimes called the Gaston Mine, in Gaston Co., N. C., where I noted this occurrence about two years ago.

A third one is in the neighborhood of Highland, Montana. Several others of minor importance will be mentioned under the different species.

The following are the results of my investigations:

1. Native Tellurium.

The occurrence at the Red Cloud Mine is fully described by Prof. Silliman. I have observed it on several specimens in small, very indistinct crystals, with rounded edges; also in one splendid cleavage piece, showa plate of $\frac{5}{8}$ of an inch in length, and nearly $\frac{1}{2}$ of an inch in width, from which I have obtained a hexagonal cleavage crystal of $\frac{5}{16}$ of an inch in length, and $\frac{1}{4}$ of an inch in thickness. Generally it is disseminated in fine grains through quartz, cleavage perfect, color tin-white, inclining to gray.

Associated with sylvanite, altaite and pyrite.

Without destroying my best specimens, I could not get enough of pure material for analysis.

2. Tetradymite.

The sulphurous variety of tetradymite has been observed at several new localities: associated with gold ores in small lead-colored scales at Spaulding Co., Georgia; also in York District, S. C.; in quartz from the gravel deposits of Burke and McDowell Counties, N. C.; in gray quartz with gold at the Montgomery Mine, Hassayampa District, Arizona; and at the "Uncle Sam's Lode," in Highland District, Montana. At the latter place it is found associated both with quartz and gold, and in dolomite. Part of it is oxydized into montanite. The latter, however, is not in a state of sufficient purity for analysis. That the tellurium is present as telluric acid, and not as tellurous acid, is proved by the large evolution of chlorine, when it is heated with chlorhydric acid.*

The tetradymite occurs here in considerable quantity, in foliated masses with foliæ sometimes $\frac{3}{4}$ of an inch in width and scaly-granular. Its color is between lead-gray and iron-black. It is often tarnished with pavonine colors.

The gold, which is often interlaminated with it, shows the striation of the tetradymite, and is evidently the result of its precipitating action upon the gold in solution, in the same manner as already stated in my notice of the pseudomorphous gold after tetradymite from the White Hall Mine (Amer. Journ. of Science [2] XXVIII., 254).

It is an interesting fact that the tetradymite from Uncle Sam's Lode contains sulphur as an essential constituent, while that from the gold placers of Highland, which I had received from Mr. Kleinschmidt, and described in the Journal of Science [2] XLV., 316, is *free* from it.

My friend Mr. P. Knabe has made some very important observations on this subject, which are contained in his letter, dated Highland, Mon-

* I notice the following misprints in Dr. Burkart's paper, "Uber das Vorkommen verschiedener Tellur-Minerale in den Vereinigten Staaten von Nord-Amerika," Leonhard & Geinitz Neues Jahrbuch der Mineralogie, etc., 1873, page 491, line 5 from bottom: *Tellursæure* instead of *Tellurige Sæure*, and on page 492, line 15, *Tellurige Sæure* instead of *Tellursæure*.

tana, Dec. 26th, 1870, of which I translate that part which refers to this subject. He says :

"*I have discovered the tetradymite which I sent you in* Uncle Sam's Lode, *in Highland District. Two years ago I examined a fragment of tetradymite from Highland Gulch, which I found to be the* sulphurous *variety, and was therefore very much surprised to find from your pamphlet that the tetradymite from Highland Gulch examined by you was the variety* without *sulphur. After I had repeatedly examined pieces of the said mineral, I made the discovery that* both varieties *of* tetradymite *are found together in Highland Gulch. This was the more interesting, since there occur in it also two different varieties of gold, which fact gives pretty conclusive evidence that the gold of the Gulch comes from* two different *formations. The finest gold of the Gulch originates undoubtedly from the garnet which occurs between the dolomite and granite. I then examined the different trial pits in the dolomite, and found in this formation at the head of the Gulch in the Uncle Sam Lode the specimens which I sent you. In the garnet rock which adjoins the Gulch on its left side, I have not yet found any tetradymite; but in a piece of garnet from the Gulch I found* gold *and* tetradymite without *sulphur. In all the samples of the sulphurous variety of tetradymite from the Gulch, as well as in that from Uncle Sam's Lode, I found a trace of selenium.*"

The following are the results of my analyses of the tetradymite from Uncle Sam's Lode :

		Broadly foliated.		Smaller scales from dolomite.
Sp. Gr.	=	7.332	—	7.542
Quartz	=	0.05	—	0.58
Gold	=	0.21	—	——
Bismuth	=	60.49	—	59.24
Copper	=	trace	—	0.47
Iron	=	0.09	—	——
Tellurium (by diff.)	=	34.90	— (by diff.)	34.41
Selenium	=	trace	—	0.14
Sulphur	=	4.26	—	15.16
		100.00		100.00

At the Red Cloud Mine, Colorado, tetradymite seems to be one of the rarest minerals. The first indication which I had of it was the observation of a small quantity of bismuth in the analysis of one of the varieties of petzite. After a great deal of search I discovered, associated with pyrite and auriferous hessite, a very few minute iron-gray scales, some of them with a bluish tarnish, which on examination proved to be the *sulphurous* variety of tetradymite.

3. Altaite.

I have discovered this rare mineral at *two* new localities—the Red Cloud Mine, Colorado, and the King's Mountain Mine, Gaston Co., N. C.

At the latter locality it is found in sugary quartz associated with gold, galenite, chalcopyrite, pyrite, antimonial tetrahedrite, and more rarely with nagyagite and a greenish micaceous mineral resembling fuchsite. It occurs in small quantities only, and is so much mixed with the other minerals, that I was unable to select enough for a quantitative analysis. It is easily recognized by its tin-white color, with the greenish-yellow hue, and its great lustre. It is found in particles showing the distinct cubical cleavage, but also finely granular. A very interesting but quite small piece shows a cleavage mass, part of which is altaite, part galenite, without any interruption in the cleavage plane, both minerals being easily distinguishable by their color.

The altaite at the Red Cloud Mine, Colorado, is found in larger masses, generally, however, very much intermixed with other minerals, especially native tellurium and sylvanite. It is associated with pyrite, siderite and quartz. Sometimes it is found in indistinct cubical crystals, apparently coated with a thin film of galenite; rarely in larger cleavage masses. I have a cleavage cube of $\frac{5}{8}$ of an inch in size of distinct cleavage: some of the planes are slightly coated with galenite. The most frequent occurrence is that in granular masses with indistinct cubical cleavage, a fracture inclining to subconchoidal and a yellowish tarnish.*

The analysis of a portion of the cleavage cube gave the following results:

Spec. Gr.	=	8.060		
Quartz	=	0.19	—	0.32
Gold	=	0.19	—	0.16
Silver	=	0.62	—	0.79
Copper	=	0.06	—	0.06
Lead	=	60.22	—	60.53
Zinc	=	0.15	—	0.04
Iron	=	0.48	—	0.33
Tellurium	=	37.99	—	37.51
		99.90		99.74

4. Hessite, Auriferous Hessite, Petzite.

Varieties of telluride of silver with variable quantities of gold are the principal minerals which give the ores of the Red Cloud Mine their value. I believe that I was the first to whom specimens of the rich auriferous variety were sent by Mr. Schirmer. These I have determined as petzite. Prof. Silliman mentions a variety (l. c.) containing 7.131 per cent. of gold and 51.061 per cent. of silver, of which he gives a very accurate description; he evidently had only this *one*, and therefore comes to the conclusion that the Red Cloud Mine contained *no* other varieties. It will be

* In Dr. Burkart's paper (l. c.) p. 487, line 12 from the bottom, read: *hexaëdrische* instead of *hexagonale*.

seen from the analyses which I give below, that there are several, from almost pure hessite without gold, up to the highly auriferous of the same composition as that from the Stanislaus and Golden Rule Mines in California.

a. HESSITE.

The pure hessite appears to be very rare. I have received only one small piece, which Mr. Schirmer distinguished as "black tellurium." It is of a dark iron-gray color, inclining to black, granular structure and uneven fracture; powder dark lead-gray; sectile. Its spec. gr. = 8.178.

It contains some cavities lined with minute crystals of pyrite and barite.

The analyses gave:

Gold	=	0.22	—	0.20
Silver	=	59.91	—	60.19
Copper	=	0.17	—	0.16
Lead	=	0.45	—	0.18
Zinc	=	trace	—	trace
Iron	=	1.35	—	1.20
Tellurium	=	37.86	by diff. =	38.07
		99.96		100.00

In all the other varieties, the difference in the appearance of the mineral is so slight that it is almost impossible to distinguish them. They all have an iron-gray color, and frequently assume by tarnishing a darker or purplish color, a subconchoidal fracture; the more argentiferous are somewhat darker, the more auriferous lighter and more brittle.

b. AURIFEROUS HESSITES.

		α, Sp. gr. = 8.789.				*β*, Sp. gr. = 8.897.
Quartz	=	0.18	—	0.13	—	0.70
Gold	=	3.31	—	3.34	—	13.09
Silver	=	59.68	—	59.83	—	50.56
Copper	=	0.05	—	0.06	—	0.07
Lead	=	——	—	——	—	0.17
Zinc	=	——	—	——	—	0.15
Iron	=	0.15	—	0.21	—	0.36
Tellurium	=	37.60	—	36.74	—	34.91
		100.97	—	100.31		100.01

c. PETZITE.

		α		*β*
Sp. Gr.	=	9.010	—	9.020
Quartz	=	0.62	—	0.05
Gold	=	24.10	—	24.69
Silver	=	40.73	—	40.80

Copper	=	trace	—	trace
Bismuth	=	0.41	—	——
Lead	=	0.26	—	——
Zinc	=	0.05	—	0.21
Iron	=	0.78	—	1.28
Tellurium	=	33.49	by diff.	32.97
		100.44		100.00

The above analyses, to which add for comparison those of Prof. Silliman and the petzite from Nagy-Ag, give the following atomic ratios between gold, silver and tellurium :

b α	=	1	:	32.7	:	34.3
Silliman	=	1	:	14	:	——
b β	=	1	:	7	:	8.2
Nagy-Ag	=	1	:	4.7	:	5.9
Petzite	=	1	:	3.1	:	4.2

From which it will be seen that gold and silver appear to replace each other in indefinite proportions, while the mixture of the two combines atom for atom with tellurium.

5. Sylvanite.

The Red Cloud Mine is the first American locality at which this mineral has been found. It was observed by Prof. Silliman, but his stock was not sufficient for a more minute description. The specimens which I have are massive, showing eminent cleavage in one direction, giving it a plated appearance. In one piece it occurs in quartz, which is penetrated by crystalline aggregations arranged in a line of over one inch in length and $\frac{1}{32}$ of an inch in thickness, resembling the real "*graphic tellurium*" from Transylvania. Its color is silver-white, with a strong gray tint; brilliant metallic lustre.

It is associated with pyrite, which, in very small crystals, is often so thickly disseminated through the mass, that it is very difficult, if not impossible, to obtain pure material for analysis.

Sp. gr. = 7.943.

		α		β		γ
Quartz	=	0.32	—	0.86	—	0.59
Gold	=	24.83	—	23.06	—	25.67
Silver	=	13.05	—	11.52	—	11.92
Copper	=	0.23	—	0.57	—	0.21
Lead	=	——	—	——	—	0.46
Zinc	=	0.45	—	0.11	—	0.06
Iron	=	3.28	—	4.84	—	1.17
Tellurium	=	56.31	—	54.60	— by diff.	=58.87
Selenium	=	trace	—	trace	—	trace
Sulphur	=	1.82	—by diff.	= 4.44	—	1.05
		100.29		100.00		100.00

The atomic ratios between gold, silver and tellurium, and the combined gold and silver and tellurium are as follows :

α Au : Ag : Te = 1 : 0.96 : 6.98 — (Au Ag) : Te = 1 : 3.6
β " : " : " = 1 : 0.91 : 7.29 -- " : " = 1 : 3.8
γ " : " : " = 1 : 0.84 : 6.45 — " : " = 1 : 3.5

6. Calaverite.

I have observed one very minute specimen of this rare mineral amongst those from the Red Cloud Mine, which Mr. Schirmer sent me. It fully answers the description which I have previously given (l. c.).

It is associated with sylvanite and quartz. It contains a somewhat smaller percentage of silver than that from the Stanislaus Mine in California.

The scarcity of the material did not allow me to obtain for analysis more than 0.1654 grs., from which 0.0050 grs. of quartz were deducted. Dr. G. A. Koenig reduced 0.0332 grs. before the blowpipe, and obtained 42.32 per cent. of gold and silver, which I then separated with the results given below.

It contains :

Gold	=	40.59	—	39.76	42.32
Silver	=	2.24	—	2.56	
Tellurium	=	57.67	— by diff.	= 57.68	
Copper and iron	=	traces		—	
		100.50		100.00	

I was in the hope that I would find in the oxydized specimens of the tellurium ores from the Red Cloud Mine interesting products of decomposition, but observed hardly anything else than native gold, sometimes in very minute scales in the partly decomposed petzite, and small quanties of cerargyrite. There is also a minute quantity of what is probably tellurate of silver present, because if the oxydized minerals be treated with ammonic hydrate, and the ammonic solution be filtered and boiled, and subsequently acidulated with nitric acid, the argentic chloride be precipitated, the filtrate from this contains both *silver* and *tellurium*.

I also observed among the oxydized pieces, one which had a yellowish coating, probably montanite ; the quantity, however, was too small for any investigation other than a determination of the presence of bismuth and tellurium.

7. Tellurate of Copper and Lead—a new mineral.

This new tellurate has been discovered by Mr. P. Knabe, in the "Iron Rod" Mine, Silver Star District, Montana. He had sent me a small quantity of the same, which consisted of an apparently uniform siskin-green powder.

I had intended to make a full investigation of the same, but unfortunately it has been mislaid or lost.

However, I will give the most important part of the information about its occurrence, which I have received in Mr. Knabe's letter, dated Highland, March 26th, 1871.

"*I send you enclosed a mineral from the Iron Rod Mine, Silver Star District, Montana, which I hope will be interesting to you. The same substance apparently is found in the Silver Star District in all the veins which occur in the crystalline states. I have not examined that from the Iron Rod Mine, because I did not want to use up a portion of the already small quantity—but in a mineral of exactly the same appearance from the "Green Campbell" Mine, in the same District, I have found oxides of copper and lead and telluric acid. I shall try to obtain it from different mines in order to ascertain whether it is constant in its composition or is a mixture. In the Green Campbell Mine it is found as a thin coating upon the selvage of the footwall, whilst in the Iron Rod Mine it occurs in the fissures of the rock.*"

In the same letter Mr. Knabe mentions the interesting fact of having examined a graphite from the Harvey Lode, occurring in the dolomite, which contains 2.1 per cent. of silver.

This is the last information which I have received from Mr. K.; in it he states that in the latter part of May, 1871, he would make explorations in the wilderness, 40 miles W. of Highland.

8. Bismuthinite.

Dr. Burkart states in an appendix to his observations (l. c.) on the American Tellurium Minerals, (Leonhard & Geinitz Neues Jahrbuch, etc., 1874, 9,) that in the Las Animas Mine on the Sugar Loaf Mountain, Colorado, bismuth ores are found—either native, or in combination with sulphur and tellurium.

The few small pieces of bismuth ores which I have seen from this locality were bismuthinite, in stout columnar aggregations, in great part converted into bismuthite, but with still a large percentage of undecomposed tersulphide.

It contained a small percentage of silver, but not *a trace of tellurium.*

9. Schirmerite—a new mineral.

Massive, finely granular, disseminated through quartz; no cleavage could be observed; fracture uneven; soft, brittle. Sp. G. = 6.737; lead-gray inclining to iron-black, lustre metallic. B. B. fuses very easily and gives the reactions of bismuth, lead, silver and sulphur.

After deducting 1.00 per cent. quartz in analysis I., and 1.07 per cent. in II., the results are as follows:

		I.		II.
Lead	—	12.69		12.76
Silver	=	22.82		24.75
Bismuth	=	46.91	by diff.	47.27
Zinc	=	0.08		0.13
Iron	=	0.03		0.07
Sulphur	=	14.41		15.02
		96.94		100.00

The atomic ratios of Pb : Ag : Bi : S are very nearly = 1 : 4 : 4 : 9, corresponding with the composition : PbS, 2 Ag_2 S, 2 Bi_2 S_3, which gives

Pb	=	11.71
Ag	=	24.45
Bi	=	47.54
S	=	16.30
		100.00

It is allied to and closely resembles cosalite.

Dedicated to J. F. L. Schirmer, Esq.

P.S. Since the reading of my paper an article has appeared in the Engineering and Mining Journal, of August 29th, 1874, on "Tellurium Ores of Colorado, by Fred. M. Endlich," which I must not pass unnoticed, as it contains several statements which I cannot endorse.

The paper shows that Dr. Endlich had not a sufficient quantity of pure material for his examinations, and therefore based his new species upon a partial examination of mixtures.

His "*Schirmerite*" is evidently nothing else but a mixture of petzite, either with pyrite or perhaps with a telluride of iron—a mineral which has not yet been found in its *pure* state, the existence of which, however, is probable from the fact that both the true and the auriferous hessites, which are quite *free* from sulphur, invariably contain a minute quantity of iron—which according to my analyses varies from 0.15 to 1.35 per cent.

If Dr. Endlich had given his name to a good species, I would very cheerfully have adopted it and given another to my new sulphbismuthide of silver and lead—but as the mixture which he describes is not entitled to a name, that of "Schirmerite" must remain for my species.

His "*Henryite*" is undoubtedly nothing but an altaite, with an admixture of pyrite.

Knowing from Mr. Schirmer, that he has given me for this investigation the purest and best of *all* the minerals which have occurred at the Red Cloud Mine, I can state without hesitation that Dr. Endlich's species have no existence.